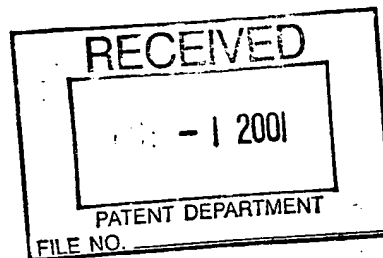




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PATENT ~~TRADEMARK~~

Docket No.: 05868 USA
Serial No.: 09/416,042 Atty.: JMF
Applicant: M. J. Roberts et al.

The stamp of the U.S. Patent and Trademark Office Mail Room hereon indicates receipt of the following:

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| <input type="checkbox"/> Assignment | <input type="checkbox"/> Appeal Brief (in triplicate) |
| <input type="checkbox"/> Assignment Transmittal Sheet | <input type="checkbox"/> Reply Brief |
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| | <input checked="" type="checkbox"/> Certificate of Mailing |
| | <u>24 September 2001</u> (Date) |
| <input type="checkbox"/> Request for Extension of Time (in duplicate) | |
| <input type="checkbox"/> Charge to Deposit Account (in duplicate) | |
| <input type="checkbox"/> Other _____ | |

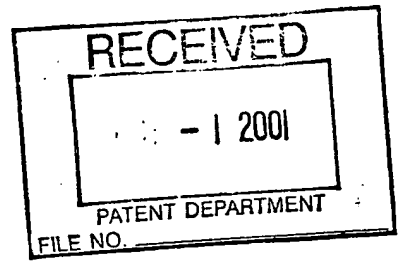
cap / 9/24/01
Sec Date

FORM 2123 (REV. 2/98)

AIR
PRODUCTS



COPY

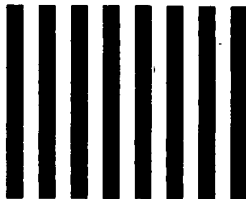


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PATENT: 05868 USA

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R/2/c*

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE **CERTIFICATE**

JAN 14 2002

IN RE APPLI-
CATION OF : M. J. Roberts et al

CORRECTION

SERIAL NO. : 09/416,042

: GRP. ART UNIT: 3744

FILED : October 1, 1999

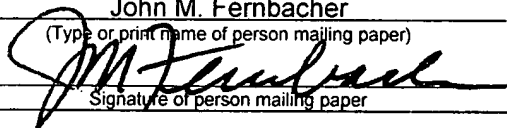
: EXAMINER: W. Doerrler

PATENT NO. : 6,308,531

: ISSUE DATE: October 30, 2001

FOR : Hybrid Cycle for the Production of Liquefied Natural Gas

Certificate of Correction Branch
Assistant Commissioner for Patents
Washington, D.C. 20231

CERTIFICATE OF MAILING	
I CERTIFY THAT THIS PAPER (ALONG WITH ANY PAPER REFERRED TO AS BEING ATTACHED OR ENCLOSED) IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE WITH SUFFICIENT POSTAGE AS FIRST CLASS MAIL IN AN ENVELOPE ADDRESSED TO:	
ASSISTANT COMMISSIONER FOR PATENTS WASHINGTON, DC 20231	
ON	<u>4 December 2001</u>
	Date
	John M. Fernbacher
	(Type or print name of person mailing paper)
	
	Signature of person mailing paper

Sir:

REQUEST TO ISSUE A CORRECTED PATENT UNDER 37 C.F.R. 1.322(b)

U. S. Patent 6,308,531 issued on October 30, 2001 based upon the above-named application. The claims and a portion of the specification as issued in this patent are incorrect. Because the nature of the errors in the claims and specification as issued constitute a mistake on the part of the Office, the patentee respectfully requests that a corrected patent be issued by the Commissioner in a timely manner without expense to the patentee.

As explained below, a simple Certificate of Correction would be inappropriate because of the extent of the errors in this patent, and therefore this request is for issue of a complete corrected patent.

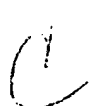
Grant under 37 C.F.R. 1.322(b)

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The appropriate portion of the prosecution history of this patent according to documents in the patentee's file wrapper is summarized below.

- February 14, 2001 Notice of Allowance mailed for Claims 1-26.
- February 23, 2001 Information Disclosure Statement mailed by Applicants submitting references cited in the European Search Report.
- May 8, 2001 Issue fee mailed.
- September 10, 2001 Telephone interview between Examiner Doerrler and the undersigned regarding German Patent 24 04 215 submitted in the IDS mailed on February 23, 2001. Agreement was reached regarding claim amendments in which Claims 1-12, 16-18, 22, 23, and 25 would be canceled and the subject matter of these claims would be incorporated into the remaining claims by Examiner's amendment.
- September 17, 2001 Office communication mailed by Examiner summarizing the interview of September 10, 2001 and presenting the Examiner's amendment as agreed.
- September 24, 2001 Applicants submitted amendments under 37 CFR 1.312 to correct an error in the Examiner's amendment of September 17, 2001 and also to amend the section of the application entitled "Brief Summary of the Invention" to bring this section in harmony with the claims as amended (MPEP 1302.01). A copy of this submittal is enclosed.
- September 26, 2001 Return receipt postcard from the USPTO for the September 24, 2001 submission received by patentee (copy enclosed).
- October 18, 2001 Issue Notification received by patentee.
- October 30, 2001 Patent 6,308,531 issued containing the specification as originally filed and Claims 1-26 as allowed February 14, 2001 (Letters Patent enclosed).

The patentee never received a 1.312 Notice that the above amendment mailed on September 24, 2001 was received and entered by the Examiner. The patentee also never received a supplemental Notice of Allowance for these amended claims.



The patentee requests the following specific corrections to issued U.S. Patent 6,308,531:

1. replace the section entitled "Brief Summary of the Invention" with the text submitted in the amendment of September 24, 2001 and repeated in Appendix 1 below; and
2. replace the ~~incorrectly-issued~~ Claims 1-24 with the corrected claims submitted in the Examiner's amendment of September 17, 2001 and in Applicants' amendment of September 24, 2001, wherein the correct claims are repeated in Appendix 1 below renumbered as Claims 1-8.

Correction of this error would require a Certificate of Correction containing at least four to five pages. The patentee submits that this is an inappropriate way to correct the subject patent, and requests that the Commissioner issue a corrected patent instead of a Certificate of Correction. This request is in accord with 37 C.F.R. 1.322(b), which states that

"If the nature of the mistake on the part of the Office is such that a certificate of correction is deemed inappropriate in form, the Commissioner may issue a corrected patent in lieu thereof as a more appropriate form for certificate of correction, without expense to the patentee."

The original Letters Patent is enclosed herewith. The patentee requests that the Commissioner issue a corrected U.S. Patent 6,308,531 for Claims 1-8 in a timely manner at an early date.

Respectfully submitted,



John M. Fernbacher
Agent for Patentee
Registration No. 32,895
7201 Hamilton Boulevard
Allentown, PA 18195-1501
(610) 481-6560

Appendices:

Text of amended portion of the specification

Text of allowed amended claims

Enclosures:

Letters Patent for U.S. 6,308,531 B1

Copy of Applicants' amendment mailed September 24, 2001

Copy of Return Receipt postcard for amendment mailed September 24, 2001

AIR PRODUCTS AND CHEMICALS, INC.

PATENT DEPARTMENT

7201 HAMILTON BLVD

ALLENTOWN, PA 18195-1501

#12/C

APPENDIX 1
AMENDED SPECIFICATION

The Specification was amended by canceling the entire section following the title "BRIEF SUMMARY OF THE INVENTION" and inserting the following text:

--The invention relates to a method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream.

The first recirculating refrigeration system may be operated by

- c'
- (1) compressing a first gaseous refrigerant;
 - (2) cooling and at least partially condensing the resulting compressed refrigerant;
 - (3) reducing the pressure of the resulting at least partially condensed compressed refrigerant;
 - (4) vaporizing the resulting reduced-pressure refrigerant to provide refrigeration in the first temperature range and yield a vaporized refrigerant;
 - and
 - (5) recirculating the vaporized refrigerant to provide the first gaseous refrigerant of (1).

At least a portion of the cooling in (2) may be provided by indirect heat exchange with one or more additional vaporizing refrigerant streams provided by a third recirculating refrigeration circuit. The third recirculating refrigeration circuit may utilize a single component refrigerant or alternatively may utilize a mixed refrigerant comprising two or more components.

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In an alternative embodiment, the invention relates to a method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream. The second recirculating refrigeration system may be operated by

- (1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);
- (2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;
- (3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);
- (4) warming the cold refrigerant to provide refrigeration in the second temperature range; and
- (5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1).

At least a portion of the cooling in (2) may be provided by indirect heat exchange with one or more additional vaporizing refrigerants provided by a third recirculating refrigeration circuit. The third recirculating refrigeration circuit may utilize a single component refrigerant or a mixed refrigerant which comprises two or more components.

In another alternative embodiment, the invention relates to a method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and

provides refrigeration in a first temperature range; and (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream. The first refrigerant system may be operated by

- (1) compressing a first gaseous refrigerant;
- (2) cooling and partially condensing the resulting compressed refrigerant to yield a vapor refrigerant fraction and a liquid refrigerant fraction;
- (3) further cooling and reducing the pressure of the liquid refrigerant fraction, and vaporizing the resulting liquid refrigerant fraction to provide refrigeration in the first temperature range and yield a first vaporized refrigerant;
- (4) cooling and condensing the vapor refrigerant fraction, reducing the pressure of at least a portion of the resulting liquid, and vaporizing the resulting liquid refrigerant fraction to provide additional refrigeration in the first temperature range and yield a second vaporized refrigerant; and
- (5) combining the first and second vaporized refrigerants to provide the first gaseous refrigerant of (1).

Vaporization of the resulting liquid in (4) may be effected at a pressure lower than the vaporization of the resulting liquid refrigerant fraction in (3), and the second vaporized refrigerant may be compressed before combining with the first vaporized refrigerant.

In a further alternative embodiment, the invention relates to a method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream. The second recirculating refrigeration system may be operated by

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- (1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);
 - (2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;
 - (3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);
 - (4) warming the cold refrigerant to provide refrigeration in the second temperature range; and
 - (5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1).

The feed gas may be natural gas, the resulting liquefied natural gas stream may be flashed to lower pressure to yield a light flash vapor and a final liquid product, and the light flash vapor may be used to provide the second gaseous refrigerant in the second refrigerant circuit.--

APPENDIX 2
AMENDED CLAIMS

The claims were amended by canceling Claims 1-12, 16-18, 22, 23, and 25, and incorporating the subject matter of these claims into the remaining claims. The patentee has renumbered remaining Claims 13-15, 19-21, 24, and 26 as Claims 1-8.

1. A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the first recirculating refrigeration system is operated by

(1) compressing a first gaseous refrigerant;

(2) cooling and at least partially condensing the resulting compressed refrigerant;

(3) reducing the pressure of the resulting at least partially condensed compressed refrigerant;

(4) vaporizing the resulting reduced-pressure refrigerant to provide refrigeration in the first temperature range and yield a vaporized refrigerant; and

(5) recirculating the vaporized refrigerant to provide the first gaseous refrigerant of (1);

wherein at least a portion of the cooling in (2) is provided by indirect heat exchange with one or more additional vaporizing refrigerant streams provided by a third recirculating refrigeration circuit.

2. The method of Claim 1 wherein the third recirculating refrigeration circuit utilizes a single component refrigerant.

3. The method of Claim 1 wherein the third recirculating refrigeration circuit utilizes a mixed refrigerant comprising two or more components.

4. A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

c2 (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the second refrigeration system is operated by

(1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);

(2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;

(3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);

(4) warming the cold refrigerant to provide refrigeration in the second temperature range; and

(5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1);

wherein at least a portion of the cooling in (2) is provided by indirect heat exchange with one or more additional vaporizing refrigerant provided by a third recirculating refrigeration circuit.

5. The method of Claim 4 wherein the third recirculating refrigeration circuit utilizes a single component refrigerant.

6. The method of Claim 4 wherein the third recirculating refrigeration circuit utilizes a mixed refrigerant which comprises two or more components.

7. A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the first refrigerant system is operated by

- (1) compressing a first gaseous refrigerant;
- (2) cooling and partially condensing the resulting compressed refrigerant to yield a vapor refrigerant fraction and a liquid refrigerant fraction;
- (3) further cooling and reducing the pressure of the liquid refrigerant fraction, and vaporizing the resulting liquid refrigerant fraction to provide

refrigeration in the first temperature range and yield a first vaporized refrigerant;

(4) cooling and condensing the vapor refrigerant fraction, reducing the pressure of at least a portion of the resulting liquid, and vaporizing the resulting liquid refrigerant fraction to provide additional refrigeration in the first temperature range and yield a second vaporized refrigerant; and

(5) combining the first and second vaporized refrigerants to provide the first gaseous refrigerant of (1);

wherein vaporization of the resulting liquid in (4) is effected at a pressure lower than the vaporization of the resulting liquid refrigerant fraction in (3), and wherein the second vaporized refrigerant is compressed before combining with the first vaporized refrigerant.

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8. A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the second refrigeration system is operated by

(1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);

(2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;

(3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);

(4) warming the cold refrigerant to provide refrigeration in the second temperature range; and

c2 (5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1);

wherein the feed gas is natural gas, the resulting liquefied natural gas stream is flashed to lower pressure to yield a light flash vapor and a final liquid product, and the light flash vapor is used to provide the second gaseous refrigerant in the second refrigerant circuit.

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,308,531 B1
DATED : October 30, 2001
INVENTOR(S) : Mark Julian Roberts

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

The attached pages should be inserted in columns 1 and 2 following the title "BRIEF SUMMARY OF THE INVENTION"

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,308,531 B1
DATED : October 30, 2001
INVENTOR(S) : Mark Julian Roberts

PMH/10810

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

The attached pages should be inserted in columns 1 and 2 following the title "BRIEF SUMMARY OF THE INVENTION"

APPENDIX 1
AMENDED SPECIFICATION

The Specification was amended by canceling the entire section following the title "BRIEF SUMMARY OF THE INVENTION" and inserting the following text:

--The invention relates to a method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream.

The first recirculating refrigeration system may be operated by

- (1) compressing a first gaseous refrigerant;
- (2) cooling and at least partially condensing the resulting compressed refrigerant;
- (3) reducing the pressure of the resulting at least partially condensed compressed refrigerant;
- (4) vaporizing the resulting reduced-pressure refrigerant to provide refrigeration in the first temperature range and yield a vaporized refrigerant;
- and
- (5) recirculating the vaporized refrigerant to provide the first gaseous refrigerant of (1).

At least a portion of the cooling in (2) may be provided by indirect heat exchange with one or more additional vaporizing refrigerant streams provided by a third recirculating refrigeration circuit. The third recirculating refrigeration circuit may utilize a single component refrigerant or alternatively may utilize a mixed refrigerant comprising two or more components.

In an alternative embodiment, the invention relates to a method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream. The second recirculating refrigeration system may be operated by

- (1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);
- (2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;
- (3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);
- (4) warming the cold refrigerant to provide refrigeration in the second temperature range; and
- (5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1).

At least a portion of the cooling in (2) may be provided by indirect heat exchange with one or more additional vaporizing refrigerants provided by a third recirculating refrigeration circuit. The third recirculating refrigeration circuit may utilize a single component refrigerant or a mixed refrigerant which comprises two or more components.

In another alternative embodiment, the invention relates to a method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and

provides refrigeration in a first temperature range; and (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream. The first refrigerant system may be operated by

- (1) compressing a first gaseous refrigerant;
- (2) cooling and partially condensing the resulting compressed refrigerant to yield a vapor refrigerant fraction and a liquid refrigerant fraction;
- (3) further cooling and reducing the pressure of the liquid refrigerant fraction, and vaporizing the resulting liquid refrigerant fraction to provide refrigeration in the first temperature range and yield a first vaporized refrigerant;
- (4) cooling and condensing the vapor refrigerant fraction, reducing the pressure of at least a portion of the resulting liquid, and vaporizing the resulting liquid refrigerant fraction to provide additional refrigeration in the first temperature range and yield a second vaporized refrigerant; and
- (5) combining the first and second vaporized refrigerants to provide the first gaseous refrigerant of (1).

Vaporization of the resulting liquid in (4) may be effected at a pressure lower than the vaporization of the resulting liquid refrigerant fraction in (3), and the second vaporized refrigerant may be compressed before combining with the first vaporized refrigerant.

In a further alternative embodiment, the invention relates to a method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream. The second recirculating refrigeration system may be operated by

- (1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);
- (2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;
- (3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);
- (4) warming the cold refrigerant to provide refrigeration in the second temperature range; and
- (5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1).

The feed gas may be natural gas, the resulting liquefied natural gas stream may be flashed to lower pressure to yield a light flash vapor and a final liquid product, and the light flash vapor may be used to provide the second gaseous refrigerant in the second refrigerant circuit.--

APPENDIX 2
AMENDED CLAIMS

The claims were amended by canceling Claims 1-12, 16-18, 22, 23, and 25, and incorporating the subject matter of these claims into the remaining claims. The patentee has renumbered remaining Claims 13-15, 19-21, 24, and 26 as Claims 1-8.

1. A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the first recirculating refrigeration system is operated by

(1) compressing a first gaseous refrigerant;

(2) cooling and at least partially condensing the resulting compressed refrigerant;

(3) reducing the pressure of the resulting at least partially condensed compressed refrigerant;

(4) vaporizing the resulting reduced-pressure refrigerant to provide refrigeration in the first temperature range and yield a vaporized refrigerant; and

(5) recirculating the vaporized refrigerant to provide the first gaseous refrigerant of (1);

wherein at least a portion of the cooling in (2) is provided by indirect heat exchange with one or more additional vaporizing refrigerant streams provided by a third recirculating refrigeration circuit.

2. The method of Claim 1 wherein the third recirculating refrigeration circuit utilizes a single component refrigerant.

3. The method of Claim 1 wherein the third recirculating refrigeration circuit utilizes a mixed refrigerant comprising two or more components.

4. A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the second refrigeration system is operated by

(1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);

(2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;

(3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);

(4) warming the cold refrigerant to provide refrigeration in the second temperature range; and

(5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1);
wherein at least a portion of the cooling in (2) is provided by indirect heat exchange with one or more additional vaporizing refrigerant provided by a third recirculating refrigeration circuit.

5. The method of Claim 4 wherein the third recirculating refrigeration circuit utilizes a single component refrigerant.

6. The method of Claim 4 wherein the third recirculating refrigeration circuit utilizes a mixed refrigerant which comprises two or more components.

7. A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the first refrigerant system is operated by

- (1) compressing a first gaseous refrigerant;
- (2) cooling and partially condensing the resulting compressed refrigerant to yield a vapor refrigerant fraction and a liquid refrigerant fraction;
- (3) further cooling and reducing the pressure of the liquid refrigerant fraction, and vaporizing the resulting liquid refrigerant fraction to provide

refrigeration in the first temperature range and yield a first vaporized refrigerant;

(4) cooling and condensing the vapor refrigerant fraction, reducing the pressure of at least a portion of the resulting liquid, and vaporizing the resulting liquid refrigerant fraction to provide additional refrigeration in the first temperature range and yield a second vaporized refrigerant; and

(5) combining the first and second vaporized refrigerants to provide the first gaseous refrigerant of (1);

wherein vaporization of the resulting liquid in (4) is effected at a pressure lower than the vaporization of the resulting liquid refrigerant fraction in (3), and wherein the second vaporized refrigerant is compressed before combining with the first vaporized refrigerant.

8. A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the second refrigeration system is operated by

(1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);

(2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;

(3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);

(4) warming the cold refrigerant to provide refrigeration in the second temperature range; and

(5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1);

wherein the feed gas is natural gas, the resulting liquefied natural gas stream is flashed to lower pressure to yield a light flash vapor and a final liquid product, and the light flash vapor is used to provide the second gaseous refrigerant in the second refrigerant circuit.

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,308,531 B1
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INVENTOR(S) : Mark Julian Roberts

Page 1 of 10

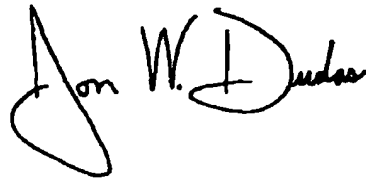
It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Columns 1 and 2,

The attached pages should be inserted following the title "BRIEF SUMMARY OF THE INVENTION".

Signed and Sealed this

Twentieth Day of July, 2004

A handwritten signature in black ink, reading "Jon W. Dudas". The signature is written in a cursive style with a large, looped initial "J".

JON W. DUDAS
Acting Director of the United States Patent and Trademark Office

APPENDIX 1
AMENDED SPECIFICATION

The Specification was amended by canceling the entire section following the title "BRIEF SUMMARY OF THE INVENTION" and inserting the following text:

—The invention relates to a method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream.

The first recirculating refrigeration system may be operated by

- (1) compressing a first gaseous refrigerant;
- (2) cooling and at least partially condensing the resulting compressed refrigerant;
- (3) reducing the pressure of the resulting at least partially condensed compressed refrigerant;
- (4) vaporizing the resulting reduced-pressure refrigerant to provide refrigeration in the first temperature range and yield a vaporized refrigerant; and
- (5) recirculating the vaporized refrigerant to provide the first gaseous refrigerant of (1).

At least a portion of the cooling in (2) may be provided by indirect heat exchange with one or more additional vaporizing refrigerant streams provided by a third recirculating refrigeration circuit. The third recirculating refrigeration circuit may utilize a single component refrigerant or alternatively may utilize a mixed refrigerant comprising two or more components.

In an alternative embodiment, the invention relates to a method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream. The second recirculating refrigeration system may be operated by

- (1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);
- (2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;
- (3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);
- (4) warming the cold refrigerant to provide refrigeration in the second temperature range; and
- (5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1).

At least a portion of the cooling in (2) may be provided by indirect heat exchange with one or more additional vaporizing refrigerants provided by a third recirculating refrigeration circuit. The third recirculating refrigeration circuit may utilize a single component refrigerant or a mixed refrigerant which comprises two or more components.

In another alternative embodiment, the invention relates to a method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and

provides refrigeration in a first temperature range; and (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream. The first refrigerant system may be operated by

- (1) compressing a first gaseous refrigerant;
- (2) cooling and partially condensing the resulting compressed refrigerant to yield a vapor refrigerant fraction and a liquid refrigerant fraction;
- (3) further cooling and reducing the pressure of the liquid refrigerant fraction, and vaporizing the resulting liquid refrigerant fraction to provide refrigeration in the first temperature range and yield a first vaporized refrigerant;
- (4) cooling and condensing the vapor refrigerant fraction, reducing the pressure of at least a portion of the resulting liquid, and vaporizing the resulting liquid refrigerant fraction to provide additional refrigeration in the first temperature range and yield a second vaporized refrigerant; and
- (5) combining the first and second vaporized refrigerants to provide the first gaseous refrigerant of (1).

Vaporization of the resulting liquid in (4) may be effected at a pressure lower than the vaporization of the resulting liquid refrigerant fraction in (3), and the second vaporized refrigerant may be compressed before combining with the first vaporized refrigerant.

In a further alternative embodiment, the invention relates to a method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream. The second recirculating refrigeration system may be operated by

- (1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);
- (2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;
- (3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);
- (4) warming the cold refrigerant to provide refrigeration in the second temperature range; and
- (5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1).

The feed gas may be natural gas, the resulting liquefied natural gas stream may be flashed to lower pressure to yield a light flash vapor and a final liquid product, and the light flash vapor may be used to provide the second gaseous refrigerant in the second refrigerant circuit.—

APPENDIX 2
AMENDED CLAIMS

The claims were amended by canceling Claims 1-12, 16-18, 22, 23, and 25, and incorporating the subject matter of these claims into the remaining claims. The patentee has renumbered remaining Claims 13-15, 19-21, 24, and 26 as Claims 1-8.

1. A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the first recirculating refrigeration system is operated by

(1) compressing a first gaseous refrigerant;

(2) cooling and at least partially condensing the resulting compressed refrigerant;

(3) reducing the pressure of the resulting at least partially condensed compressed refrigerant;

(4) vaporizing the resulting reduced-pressure refrigerant to provide refrigeration in the first temperature range and yield a vaporized refrigerant; and

(5) recirculating the vaporized refrigerant to provide the first gaseous refrigerant of (1);

wherein at least a portion of the cooling in (2) is provided by indirect heat exchange with one or more additional vaporizing refrigerant streams provided by a third recirculating refrigeration circuit.

2. The method of Claim 1 wherein the third recirculating refrigeration circuit utilizes a single component refrigerant.

3. The method of Claim 1 wherein the third recirculating refrigeration circuit utilizes a mixed refrigerant comprising two or more components.

4. A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

- (a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

- (b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the second refrigeration system is operated by

- (1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);

- (2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;

- (3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);

- (4) warming the cold refrigerant to provide refrigeration in the second temperature range; and

(5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1);

wherein at least a portion of the cooling in (2) is provided by indirect heat exchange with one or more additional vaporizing refrigerant provided by a third recirculating refrigeration circuit.

5. The method of Claim 4 wherein the third recirculating refrigeration circuit utilizes a single component refrigerant.

6. The method of Claim 4 wherein the third recirculating refrigeration circuit utilizes a mixed refrigerant which comprises two or more components.

7. A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the first refrigerant system is operated by

- (1) compressing a first gaseous refrigerant;
 - (2) cooling and partially condensing the resulting compressed refrigerant to yield a vapor refrigerant fraction and a liquid refrigerant fraction;
 - (3) further cooling and reducing the pressure of the liquid refrigerant fraction, and vaporizing the resulting liquid refrigerant fraction to provide
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refrigeration in the first temperature range and yield a first vaporized refrigerant;

(4) cooling and condensing the vapor refrigerant fraction, reducing the pressure of at least a portion of the resulting liquid, and vaporizing the resulting liquid refrigerant fraction to provide additional refrigeration in the first temperature range and yield a second vaporized refrigerant; and

(5) combining the first and second vaporized refrigerants to provide the first gaseous refrigerant of (1);

wherein vaporization of the resulting liquid in (4) is effected at a pressure lower than the vaporization of the resulting liquid refrigerant fraction in (3), and wherein the second vaporized refrigerant is compressed before combining with the first vaporized refrigerant.

8. A method for the liquefaction of a feed gas which comprises providing at least a portion of the total refrigeration required to cool and condense the feed gas by utilizing

(a) a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range; and

(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream;

wherein the second refrigeration system is operated by

(1) compressing a second gaseous refrigerant to provide the pressurized gaseous refrigerant in (b);

(2) cooling the pressurized gaseous refrigerant to yield a cooled gaseous refrigerant;

(3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b);

(4) warming the cold refrigerant to provide refrigeration in the second temperature range; and

(5) recirculating the resulting warmed refrigerant to provide the second gaseous refrigerant of (1);

wherein the feed gas is natural gas, the resulting liquefied natural gas stream is flashed to lower pressure to yield a light flash vapor and a final liquid product, and the light flash vapor is used to provide the second gaseous refrigerant in the second refrigerant circuit.
